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ORIGINAL PAPERS

Diet, Physical Activity, and Their Impact on Chronic Diseases (Hypertension and T2DM) among North-Eastern Morocco's Population

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Abstract

Morocco is a country in "nutritional transition", with a traditional Mediterranean food model that is increasingly moving towards a Western model. To study this transition, we aimed to determine the prevalence of chronic diseases (hypertension and T2DM) and their associated factors such as food consumption and physical activity in an adult population in two provinces in the eastern region (Berkane and Nador). A food frequency and physical activity analysis questionnaire (IPAQ International Physical Activity Questionnaire) was used. The results showed a total prevalence of T2DM of 23% and of hypertension of 18%, of which 12% were new cases of T2DM and 6% were incidentally discovered hypertensives. A dietary imbalance was observed more in type 2 diabetics than in hypertensives, either through overconsumption of fatty products, red meats ($p=0.006$), dairy products ($p=0.0001$), and sweet products ($p=0.015$) or through underconsumption of fruit and vegetables ($p=0.043$) and cereals ($p=0.004$). In total, 47% of our respondents were strongly adherent to the Mediterranean diet, compared with 53% who were poor adherents. Adherence was unequal among T2DM and hypertensive patients (46.15% vs. 39%). According to the IPAQ questionnaire, 57% were inactive and the vast majority 98% were sedentary. The same trend was observed in diabetics and hypertensives, who were inactive in 44% and 59% respectively, and more sedentary in 98% of cases of T2DM and 99% of cases of arterial hypertension. This study shows an imbalance in the diet of the general and specific populations, either through over- or under-consumption of certain food products. Adherence to the Mediterranean diet was high in 47% of cases, suggesting that the remaining 53% were adopting a Western diet and that this community was inactive and highly sedentary, putting them at greater risk of chronic disease in the future.

Keywords: Diet, Physical activity, Chronic disease, Eastern region, T2DM, hypertension.

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INTRODUCTION

Chronic diseases are now the biggest health problem in the world¹. There are many risk factors for these diseases, including poor-quality diet, insufficient physical activity, and long periods of inactivity. These behaviors are also at the root of overweight and obesity, which are themselves risk factors leading to non-communicable diseases such as high blood pressure (HTA) and type 2 diabetes (T2D)². Data indicates that the prevalence of T2DM and hypertension is increasing rapidly, particularly in low- and middle-income countries¹. Consumption of fruit and vegetables remains low in all countries, with daily consumption of five fruit and vegetables rarely reaching 40%². In 2017, insufficient consumption of fruit and vegetables is estimated to have been responsible for 3.9 million deaths worldwide³. Physical inactivity is the fourth leading risk factor for premature mortality worldwide (6% of deaths), just after hypertension (13%), smoking (9%), and high blood glucose levels (6%)⁴. In the Eastern Mediterranean region, the level of physical activity is the lowest (more than 70% of adults are not physically active, especially women) and more and more people have a sedentary lifestyle⁵. This has a direct influence on weight gain, which in turn increases the risk of hypertension, T2D, and cardiovascular disease⁵. Morocco, a country in the MENA region, is no exception. For some years now, Morocco has been entering a phase of “nutritional and epidemiological transition”, characterized by an increase in non-communicable diseases and a decline in communicable diseases⁶. As a result, it is considered among the countries with high mortality from chronic diseases 84% (four out of five deaths), which exceeds the world average of 70%⁷. This situation is largely due to a nutritional transition marked by a move away from the traditional Mediterranean diet towards a standard Western diet⁶.

The Mediterranean diet is known by low-calorie and rich in vitamins and minerals derived from vegetables and fruit, wholegrain cereals, nuts, virgin olive oil, and fish, ensuring adequate intakes of micronutrients. It is known as one of the healthiest diets⁶. This diet also includes moderate consumption of eggs, dairy products, and consumption in

reduced quantities and frequency of red meats, processed meats, and foods rich in sugars and fats⁶.

In our study, our objective was to substantiate the characteristics of this transition. This involved determining the occurrence of Type 2 diabetes (T2DM) and hypertension within the two provinces situated in the eastern region, namely Berkane and Nador. Additionally, we investigated the influencing factors encompassing dietary patterns and the extent of physical activity among the adult populace within this community.

Nutritional transition

The nutritional transition is a stage frequently referred to as the ‘Westernization’ of eating habits. It refers to the transition from a diet rich in fiber, starch, and low in fat, and a physically active lifestyle, to a diet low in vegetables, fruit, and fiber, high in refined sugars, saturated animal fats, and processed industrial foods, and associated with a sedentary lifestyle. This nutritional transition is conducive to excess metabolic diseases such as hypertension, type 2 diabetes, dyslipidemia, and obesity, as well as cardiovascular disease and certain cancers⁸.

Mediterranean diet

This diet is based essentially on vegetables, fruit and nuts, olive oil, cereals, and sufficient quantities of water; the main source of lipids in the RM is olive oil, combined with moderate consumption of dairy products and reduced consumption of red meat, processed meat and foods rich in sugars and fats. The effectiveness of this diet is often linked to the fact that it contains fewer calories than so-called ‘Western’ diets⁸.

MATERIAL AND METHODS

Study site

The province of Berkane is located in northeastern Morocco. It covers a total area of 1985 km² (2.2% of the total area of the region). The province has a population of 289,137 (12.5% of the region’s total population, with a density of 145.7 inhabitants/km²). The urbanization rate in Berkane province is 63.2%⁹.

The province of Nador is located in north-eastern Morocco, covering an area of 3,221 km² and stretching along 153 km of coastline. It

occupies a strategic geographical position and is the Mediterranean gateway to Europe. According to the 2014 general population census, there are 565,426 inhabitants of the city of Nador, of whom 392,623 (69.4%) live in urban areas and 172,803 (30.6%) in rural areas¹⁰.

Sampling

In each province a sample was calculated based on formula (1), using a prevalence of hypertension of 30%. The figure obtained by this calculation was increased by 5%, giving a sample size of 800 subjects. Sampling was carried out using a random technique that involved recruiting respondents until the specified number was reached in each health center (40 consultants). The survey was a cross-sectional one, carried out between 2019 and 2020 in urban and rural localities in the two provinces. Participants were primary care facility attendants aged 18 or over, who were asked to give their consent before answering. In addition to socio-demographic and clinical questions, the questionnaire included two sections: a nutritional section asking about the diet adopted in the last seven days, and the other relating to the consultants' level of physical activity using the IPAQ questionnaire.

$$(1) \quad N = \frac{Z^2 P (1-P)}{2a}$$

- Sweet drinks: tea, coffee, juice, nectar, cola, lemonade, etc.
- Sweet products: honey, jam, ice cream, chocolate spreads, cakes, biscuits, pastries, etc.
- Fatty products: chips, crisps, khali (is a traditional Moroccan food made from prepared meat dried with salt and sun and then mixed with fat), butter, mayonnaise, mustard, ketchup...
- The portions for each component of the diet have been calculated in pieces, number of glasses of tea, bowls, or plates, number of spoons to quantify the nutrient intake.

Calculating the Mediterranean diet adherence score

The food groups and nutrients used to calculate the Mediterranean diet score were: vegetables and

fruit, fish, wholegrain cereals, olive oil, dairy products, red and processed meat, and water intake. For each of these components, a value of 0 or 1 was assigned. For the 'beneficial' components (vegetables and fruit, olive oil, wholegrain cereals, fish, water intake), a value of 1 was assigned to people whose consumption was equal to or above average, while a value of 0 was assigned to people whose consumption was below average. For the deleterious components (dairy products, red and processed meat), a value of 1 was assigned to people whose consumption was below average and 0 for people whose consumption was equal to or above average. Calculation of the MR adherence score was based on the reported frequency of weekly consumption of each food group. Each of the seven components was assigned a value of 0 or 1.

As olive oil is the main food source of Monounsaturated Fatty Acids (MUFA) in Morocco, it was given a value of 1 for consumers and 0 for non-consumers. Thus, the total MR score is between 0 and 7: the total MR score from 0 to 3 represents minimal adherence to the traditional MR, and the score from 4 to 7 represents maximum adherence to the traditional MR.

Calculating the physical activity score

Physical activity was classified into three categories: intense activity, moderate activity, and walking. For each category we calculated the level of energy expenditure in METs and then combined these three criteria to obtain a physical activity score, the total sum per week of MET recommended for health between 8.3 and 16.7 MET.h/week. A score < 8.3 MET.h/week: inactive; above 8.3 MET.h/week: active.

Sedentary lifestyle

estimate of time spent sitting or lying down (less than 4 hours of a low sedentary lifestyle and more than 4 hours of a high sedentary lifestyle). A value of 0 was assigned to a high level of sedentary behavior and a value of 1 to a low level of sedentary behavior).

Statistical analysis

Descriptive analyses were first used to determine the frequency of consumption of food products in the overall sample. A normality test was performed (Shapiro Wilk <0.005), so the distribution follows an abnormal distribution. Non-parametric

tests were used to analyze the variables: Mann-Whitney and Kruskal-Wallis tests using SPSS software (version 22.0). The significance level was set at 0.05.

RESULTS

1- Characteristics of the study population (table 1)

Our sample included 800 consultants (402 from Berkane and 398 from Nador), with women accounting for the largest proportion (79%). According to place of residence, 56% were from urban areas and 44% from rural areas. Around 40% of our population was illiterate, and more than half (59%) had no occupation.

The total prevalence of T2DM was 23% (182) in both study sites, higher in Nador at 12.12% (97) compared with 10% (85) in Berkane. The prevalence of hypertension was 17.62% (141) in the total population, while it was higher in Nador at 9.25% (74) compared with 8.37% (67) in Berkane (Figure 1a).

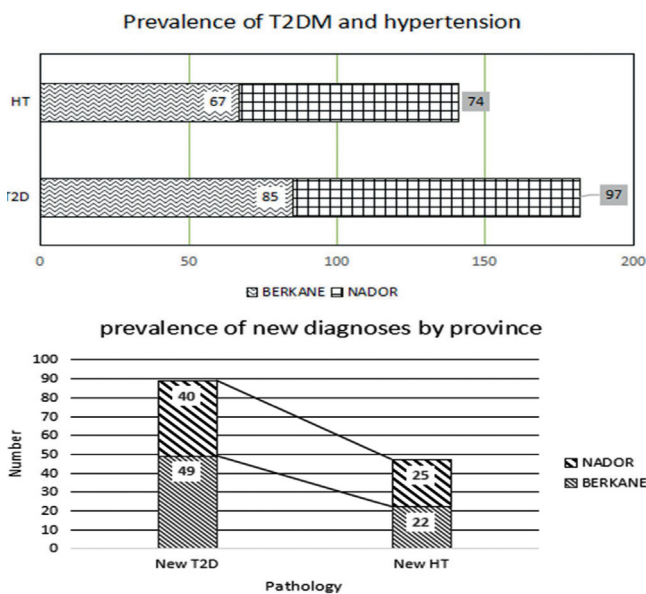


Figure 1. a) prevalence of T2DM and hypertension by province
b) prevalence of new diagnoses by province

The Hb1ac results detected new diabetics. There were 89 cases, representing 11.12% of the population examined. The proportion of newly diagnosed diabetics was higher in Berkane, with 49 cases (6.12%), compared with 40 (5%) in Nador. Similarly, when arterial blood pressure was taken,

47 cases (5.87%) of new cases of hypertension were found, divided between 25 cases in Nador and 22 cases in Berkane (Figure 1b).

Analysis using the Mann-Witney U test showed a strong association between T2DM and most of the sociodemographic and anthropometric variables of the consultants: origin (Berkane or Nador), age, place of residence, level of education and BMI ($P < 0.0001$) and physical activity ($p = 0.004$). T2DM was more common in Berkane than in Nador (57.14% vs. 39%), more prevalent in urban areas (52% vs. 44% in rural areas), in populations aged between 38 and 57 (48%), with a low level of education (illiterate) (55%) and overweight (overweight or obese) (34.61% of T2DM were overweight and 42.30% obese, compared with 30% of hypertensive patients who were overweight and 52% obese). However, we found that the physical activity (PA) score was high in 41.13% of hypertensives and 56% of T2DM.

As for hypertension, it was correlated only with origin ($p = 0.007$), age, level of education and BMI ($p < 0.0001$). The prevalence of hypertension was higher in Nador (53.19%) than in Berkane (47.51%), in city dwellers (52%) than in rural residents (47%), in those aged between 38 and 57 (50%), illiterate (70%) and obese (52%) (Table 1).

2- Dietary components and adherence to MR

A. In the general population

From the data relating to the components of the diet of our population, we found an over-consumption of certain products that are harmful to health, first and foremost the consumption of fatty products (butter, chips, khlii, ...) with a significant proportion of 92.5%, red meat with 75.12%, sweet products (chocolates, cakes, pastries....) with 56%, sweet drinks with 45.5% and dairy products with 43.12% (Figure 2).

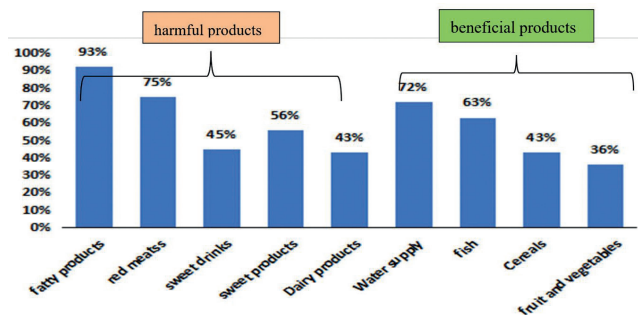


Figure 2. Components of the diet of people living in the eastern region.

Table 1: Characteristics of the study population (Mann-Witney U test)

	Without DT (n=590)	with DT (n=182)	P value	without HTA (n=657)	With HTA (n=141)	P Value
Province						
Berkane	280 (47,45%)	104 (57,14%)	0,0001	335 (51%)	67(47,51%)	0,007
Nador	310(52,54%)	71 (39%)		322 (49%)	75(53,19%)	
Gender						
Women	480(81,35%)	131(72%)	0,607	142(21,61%)	118 (83,68%)	0,943
Men	110(18,64%)	44(24,17%)		515(78,38%)	24 (17,02%)	
Residence						
Urban	330(56%)	95(52,19%)		377(57,38%)	74(52,48%)	0,224
rural	260(44%)	80(43,9%)		280(42,61%)	67(47,51%)	
age						
[18-37]	330(56%)	27(14,83%)	0,0001	348(53%)	13(9,21%)	0,001
[38-57]	210(35,59%)	88(48,35%)		244(37,13%)	71(50,35%)	
[58-77]	46(7,79%)	57(31,31%)		61(9,28%)	54(38,29%)	
>77	04(0,6%)	03(1,6%)		04(0,6%)	03(2,12)	
Level of education						
Illiterate	200(33,89%)	100 (55%)	0,0001	219(33,33%)	99(70,12%)	0,0001
Primary	120(20,33%)	29(16%)		147(22,37%)	15(10,61%)	
Secondary	126(21,35%)	38(20,87%)		146(22,22%)	20(14,18%)	
higher	144(24,40%)	8(4,39%)		145(22%)	08(5,67%)	
Profession						
Housewife	240(40,67%)	78(42,85%)	0,134	269(41%)	65(46,09%)	0,408
Student	80(13,5%)	3(1,64%)		83(12,63%)	04(2,83%)	
Employed	165(28%)	67(36,81%)		200(30,44%)	39(27,65%)	
No profession	105(17,79%)	27(14,83%)		105(16%)	04(2,83%)	
BMI						
Normal	210(35,59%)	35(19,23%)	0,0001	221(33,63%)	28(19,85%)	0,0001
Overweight	230(39%)	63(34,61%)		255(38,81%)	45(30%)	
obese	150(25,42%)	77(42,30%)		181(27,54%)	73(51,77%)	
PA						
Low	356(60,33%)	80(43,8%)	0,004	367(55,85%)	83(58,86%)	0,100
High	234(39,66%)	102(56%)		290(59,36%)	58(41,13%)	
Sedentary						
<4h	14(2,37%)	4(2,19%)	0,255	17(2,58%)	1(0,70%)	0,549
>4h	576(97,62%)	178(97,8%)		640(97,41%)	140(99%)	

Nb: 25 people with T1D were excluded, BMI: body mass index, PA: physical activity

Consumption of beneficial products was below average in the case of water intake (less than 1.5 liters per day) in 72.37% of cases, fish in 63.12%, cereals in 43.37%, and fruit and vegetables in 36.37%.

B. In people with T2DM and hypertension

According to the results in Table 2, we found a significant difference in the consumption of certain foods in the two population groups (with T2DM and without diabetes). These were mainly dairy products ($p < 0.0001$), red meat ($p = 0.006$), cereals ($p = 0.004$), fruit and vegetables ($p = 0.043$), and sweet products ($p = 0.015$). However, in the case of hypertension, this difference was only significant in the consumption of cereals ($p < 0.0001$) and sweetened products ($p = 0.002$) (figure 3).

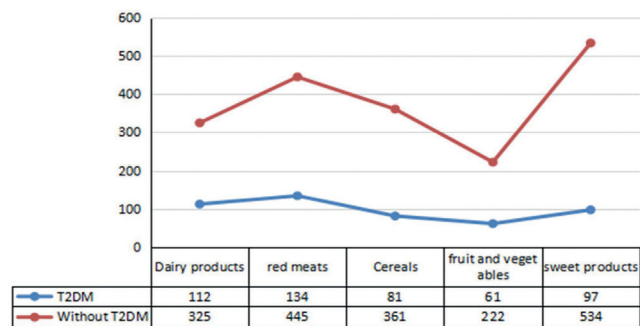


Figure 3. Food consumption in T2DM and non-diabetics.

From the list of products consumed, we calculated the score for adherence to the Mediterranean diet, which was high among non-diabetics in 47% of cases, compared with 53% for low adherence, whereas among diabetics, high adherence concerned only 44.57% of cases, compared with 55.4% for low adherence (Figure 4).

For arterial hypertension, the same trends were observed in both groups with and without hypertension, with no significant relationship ($P = 0.363$). 43.5% of hypertensives strongly adhered to the RM compared with 56%. On the other hand, 49% of respondents without hypertension had high adherence, compared with 51% with low adherence (Figure 4).

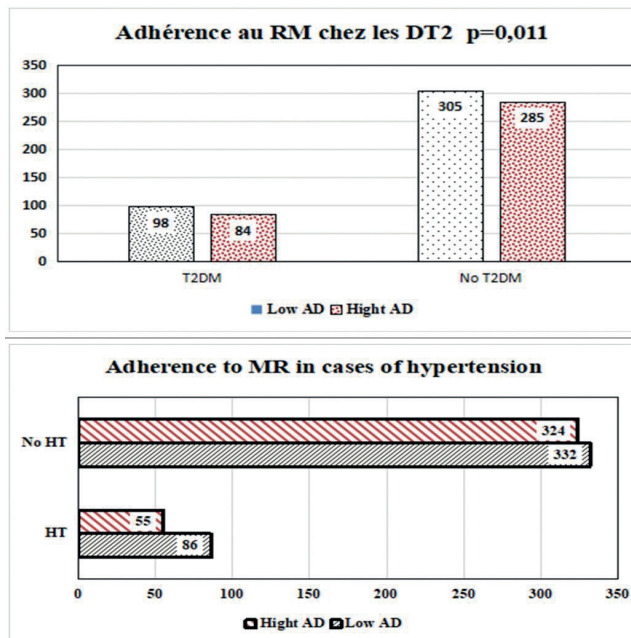


Figure 4. Adherence to MR as a function of CD

3- Estimation of the level of physical activity and sedentariness among respondents

The data in Table 3 showed a highly significant relationship ($p < 0.0001$) between low levels of physical activity and socio-demographic variables.

According to the city of origin (Berkane or Nador), we found that the populations of the city of Nador were more inactive than those of the province of Berkane $p < 0.0001$. (Figure 5a). Thus, the women in our series had a low level of physical activity of less than 8.3 METs per day, with a highly significant association $p < 0.0001$. Our results showed that rural residents had a lower level of PA than city dwellers $p < 0.0001$. People with a low level of education (illiterate) are less active than those with secondary education or higher $P < 0.0001$. For patients with co-morbidity, hypertensives were more inactive than T2DM $p = 0.004$ (59%vs44%) (Figure 5a).

Sedentary lifestyle score: according to the number of hours spent in a seated position, we found that a high level of sedentary lifestyle was associated only with the city of origin (Berkane or Nador), where the populations of the two sites were more sedentary (48.2% vs 49.5%) with a highly significant relationship $p < 0.0001$ (Figure 5b).

Table 2. Components of the diet of healthy consultants and those with CD

Diet	Without T2D (n=590)	With T2D (n=182)	P value	without HT (n=657)	with HT (n=141)	P value
Dairy products <Average >Average	270(45,76% 320(54,23%)	67(36,81% 115(63,18%)	0,0001	367(55,85% 290(44,14%)	87(61,70% 55(39%)	0,135
red meats <Average >Average	150(25,42% 440(74,57%)	45(24,72% 137(75,28%)	0,006	174(26,48% 483(73,51%)	24(17% 118(83,68%)	0,319
Water supply <1,5l >1,5l	450(76,27% 140(23,72%)	118(64,83% 64(35,16%)	0,932	476(72,45% 181(27,54%)	103(73,04% 39(27,65%)	0,106
Cereals <Average >Average	230(39% 360(61%)	98(53,84% 84(46,15%)	0,004	264(40,18% 393(59,81%)	83(58,86% 59(41,84%)	0,001
olive oil Yes No	530(89,83% 60(10,16%)	162(89% 20(11%)	0,079	582(88,58% 75(11,41%)	136(96,45% 06(4,25%)	0,065
fruit and vege- tables <Average >Average	220(37,28% 370(62,71%)	65(35,71% 117(64,28%)	0,043	245(37,29% 412(62,70%)	46(32,62% 96(68,08%)	0,413
Fish <Average >Average	370(62,71% 220(37,28%)	125(68,7% 57(31,3%)	0,299	417(63,47% 240(36,52%)	50(35,46% 92(65,24%)	0,654
sweet drinks <Average >Average	320(54,23% 270(45,67%)	105(57,69% 77(42,30%)	0,754	357(54,33% 300(45,66%)	78(55,31% 64(45,39%)	0,071
sweet products <Average >Average	260(44% 330(56%)	82(45,05% 100(55%)	0,015	290(44,14% 367(55,85%)	62(44% 79(56%)	0,002
fatty products <Average >Average	30(5,08% 560(95%)	27(14,9% 155(85,16%)	0,776	42(6,39% 615(93,60)	17(12% 125(88,65%)	0,014

Table 3. Consultants' IPAQ physical activity scores

	Physical activity			Sedentary lifestyle		
	Low PA (N=453) 56,7%<8,3 MET	Hight PA (n=346)43,3% >8,3 MET	P value	Low <4h (n=18)	Hight>4h (n=781) 97,8%	P value
Province Berkane Nador	108 (24%) 342(76%)	291(84%) 55(16%)	0,0001	17 1	385(49%) 396(51%)	0,0001
Residence Urban Rural	211(47%) 239(53%)	240(69%) 109(31%)	0,0001	13 05	438(56%) 343(44%)	0,172
Gender Men Women	73(16%) 377(84%)	93(27%) 253(73%)	0,0001	14 04	619(79%) 162(21%)	
Age 18-37 38-57 58-77 >78	207(46%) 170(37%) 69(15%) 7 (2%)	154(44%) 147(42,5%) 44(13%) 1 (0,5%)	0,344	10 07 01 0	353(45%) 308(39%) 114(15%) 6(1%)	0,430
Level of edu- cation Illiterate Primary Secondary higher	204(45%) 96(21%) 74(16%) 76 (18%)	114(33%) 66(19%) 92(27%) 77 (21%)	0,0001	8 4 2 4	310(40%) 158(20%) 164(21%) 149(19%)	0,740
Profession Housewife Student Employed No profession	89(20%) 205(46%) 54(10%) 24(5%)	50 (15%) 129 (37%) 33 (10%) 63 (18%)	0,0001	0 10 2 06	139(18%) 324(42%) 85(11%) 202(26%)	0,399
HT	83(58,86%)	59(41,84%)	0,16	1	140 (99,29%)	0,549
T2DM	80(44%)	102(56%)	0,0001	4	178 (97,80%)	0,255

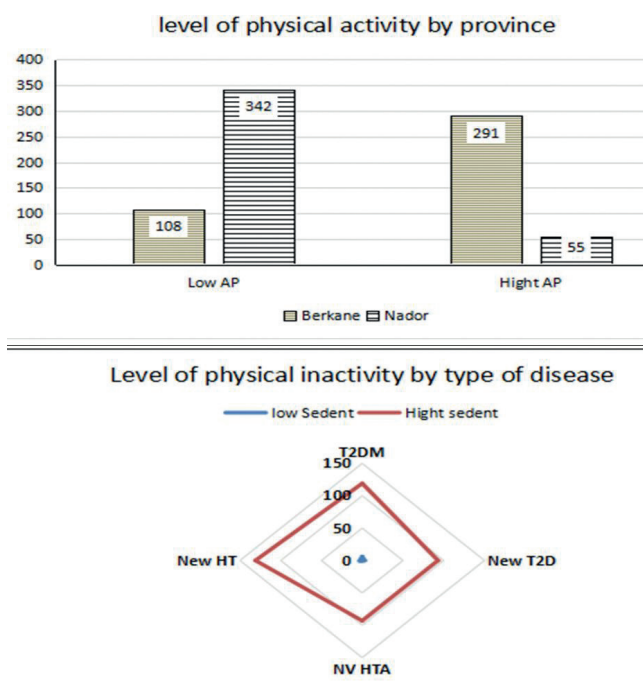


Figure 5. a) Level of physical activity by province.
b) level of physical inactivity in patients with T2DM and hypertension

Similarly, we found no difference in the level of physical inactivity between patients with T2DM or hypertension. They were sedentary in the majority of cases (97.80% vs 99.29%).

DISCUSSION

The present study showed high prevalences of hypertension (17.62%) and T2DM (23%) in our population. This proportion should increase given the rate of new cases of T2DM detected incidentally (12%) and of hypertension (6%). According to the composition of the diet, we found an over-consumption of fatty products, processed red meats, sweetened products and dairy products, compared with an under-consumption of beneficial products such as water intake, cereals, fruit and vegetables and fish in the healthy populations and those with CD (hypertension, T2DM). Adherence to the Mediterranean diet was high in only 47.5% of our consultants, compared with 53% who were less adherent to the RM. Similarly, adherence to the RM was higher in T2DM than in hypertensive

patients (46.15% vs. 39%). However, in our series, 44% of T2DM and 59% of hypertensives were inactive, while 98% of T2DM and 99% of hypertensives were more sedentary, spending more than 4 hours a day in a seated position.

Prevalence of T2DM and hypertension and new cases

In our study population, the prevalence of T2DM was 23%, with a difference between the two sites (13% in Berkane compared with 10.62% in Nador). These prevalences are close to the estimates recorded national level of 10.6%¹¹, while they exceeded the prevalences recorded in the prefecture of Oujda of 6.6% and 6.7% in the city of Rabat¹². In a study carried out by our research team, we noted that the age of diabetics in Oujda tended to move towards younger age groups, with 18% of patients aged under 34¹³. This mutation may be lifestyle-related (diet and sedentary lifestyle)¹⁴. On the other hand, Mohtadi et al. (2019) reported a higher prevalence than we found, similar to 38.1% with female dominance¹⁵. New diabetics detected incidentally were around 12%. This finding was raised by Mouzouni et al. 2021, who demonstrated a prevalence of 12.8% of undiagnosed diabetes in the two regions of Grand Casa and Rabat¹⁶. However, Maoui et al. indicated that more than half of patients are unaware of their diabetes, which means that the reported prevalence is often lower than that which exists¹⁷ (Maoui et al., 2019). In America, only 4.3% of American adults have been incidentally detected as diabetic¹⁸.

The prevalence of hypertension was 18%, higher in Nador (9.25%) than in Berkane (8.37%). This result is lower than the national “stepways” survey, which showed a prevalence of 29.9% (Ministry of Health Morocco., 2018) and 31.7% in Oujda¹⁹.

This prevalence is also lower than those found in other North African countries (36.2% in Tlemcen, Algeria; 31% in Tunisia), and those reported by developed countries around the Mediterranean (38% in Italy; 45% in Spain)²⁰.

Diet components and MR adherence

In our series, we observed overconsumption of certain products such as dairy products ($P < 0.0001$), red meat ($p = 0.006$), fatty products ($p = 0.014$), and sweet products ($p = 0.015$) with a significant

difference between the healthy population and those with T2DM and no difference with hypertensive patients. This result corroborates those reported by Houti et al. in Oran, Algeria, who showed that 51.3% of subjects consumed dairy products and 67.6% sweet desserts more than the average²¹.

Cereals and olive oil are still widely consumed in this region (at least twice a day), with a significant difference between the two populations: 45.2% and 67.2% in the healthy population and 10.3% and 20% in T2DM. Moreover, these two foods are among the main components of Moroccan cuisine and are eaten at every meal, as an accompaniment to the basic dish²².

Consumption of fruit and vegetables as the main component of the MR was well below average at 37.28%, with a significant difference between diabetics and non-diabetics ($p=0.043$). This finding was raised by Allali in 2017, assigning the installation of the first features of a nutritional transition in Morocco²². The other beneficial foods (fish and water intake) were consumed less but with no significant difference between the two groups.

This imbalance in the diet is classically described as the Westernization of behavior, which manifests itself in a deviation from the Mediterranean food model towards a standard model²². Our study confirmed this finding since only 47% of the population strongly adheres to the RM. This change heralded the onset of the first features of a nutritional transition, resulting in a shift from a diet rich in starch and fiber, low in fat, and a physically active lifestyle to a more diversified diet but rich in sugars, saturated animal fats and processed foods, and a sedentary lifestyle²².

This environment is conducive to the development of overload metabolic diseases - obesity, hypertension, dyslipidemia, diabetes - cardiovascular diseases, and certain cancers²². Numerous studies have shown that reduced adherence to RM is associated with a high prevalence of one or more cardiovascular risk factors, such as hypertension, diabetes, and hypercholesterolemia⁸.

Level of physical activity and sedentariness

More than half (56.7%) of our population had a low level of physical activity, compared with 43.3% who were active. This result is close to those

announced by the World Health Organisation (WHO), which states that 60% of the world's population fails to maintain activity at the recommended level²³. However, these results are higher than the data reported in the INCA3 (National Institute of food safety) study, which showed that 45% of men and 55% of women were inactive²⁴. According to Loyen et al, if we take objective measurements of PA (accelerometers), it is 70% of inactive adults (Loyen et al., 2016). The practice of physical activity is declining, with only 50% of young people declaring that they are physically active²².

The level of physical activity was statistically associated with the city of origin, gender, level of education, and occupation ($p<0.0001$). High levels of physical activity were found in the city of Berkane, which may be related to work in agriculture (agriculture city). Similarly, differences in the rate of physical inactivity were found in other towns in the kingdom, such as Oujda, where 79.1% of women were inactive, and Meknes, where 98% were inactive^{25,26}.

The relationship between the female sex and sedentariness has long been demonstrated. Women tend to be more obese, which subsequently affects their physical activity²⁷. Our study carried out in the town of Berkane showed that the rate of abdominal obesity observed was equivalent to 61%, particularly among inactive women in 74% of cases²⁸. These results can also be explained by the fact that our study included more women than men on the one hand, while on the other hand, these women did not carry out any professional activity (30.4% were housewives).

Level of education has been identified as a significant predictor of physical inactivity. This is probably the case in the Greek and American populations where the risk of being inactive and obese was lower in educated women than in illiterate ones, also in Japan and Lebanon less educated people had a higher sedentary rate²⁷.

Sedentary lifestyle

Sedentary time was also high, with 97.8% of people spending more than 4 hours a day sitting or lying down. Sedentary behavior is thought to be responsible for 8% of premature deaths per hour spent sitting for more than 8 hours a day. It is

associated with all causes of mortality and specific morbidity: cardiovascular mortality with an incidence of between 1.95 and 5.32; incidence of cancer between 1.33 and 3.67; incidence of death from type 2 diabetes between 1.77 and 2.87²⁹.

The most recent meta-analysis included six cohort studies using accelerometers (33,386 subjects). It showed that mortality increased progressively from 9 hours of inactivity per day, with an increased risk of overall mortality of 48% for 10 h/d (IC95%: 1.22-1.79) and multiplied by 2.92 (IC95%: 2.24-3.83) for 12 h/d in a seated position²⁴.

CONCLUSION

The results of our study confirmed the nature of the nutritional transition underway in the eastern region. Firstly, the high prevalence of T2DM and hypertension are related to changes in lifestyle and increased urbanization. Secondly, an unbalanced diet influences adherence to RM, which is strong in only 47% of cases. Thirdly, a sedentary lifestyle constitutes a favorable environment for the development of overload metabolic diseases and their cardiovascular complications. To this end, it is necessary to establish strategies to combat sedentary lifestyles and encourage people in Berkane and Nador to take up physical activity. Educational messages about diet and physical activity need to be disseminated in urban areas, among women very early on, from childhood and adolescence onwards. This will essentially help to reduce the risk of metabolic and cardiovascular diseases among tomorrow's adults. Finally, we need to continue this work with larger cohorts and use more objective tools to measure dietary intake and levels of physical activity. In populations at risk of chronic disease (T2D and hypertension), this will require optimal monitoring and management, including the nutritional component, which is the cornerstone of the therapeutic process.

Ethics

No funding for this study.

The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law.

Informed consent was obtained from all the patients included in the study.

Conflict of interest

There are no conflicts of interest regarding this article."

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